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Technical Publications Program

A Working Guide

1979



NASA

Technical Publications Program

A Working Guide

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Technical Publications Program: A Working Guide

Scientific and Technical Information Branch
National Aeronautics and Space Administration
Washington, D.C.

INTRODUCTION

1. This document answers many of the questions that arise during the day-to-day activities of NASA's agency-wide scientific and technical publication program. It provides information on the policies and procedures of the program. In addition to serving as a guide for NASA Headquarters and NASA field installation personnel, this publication may be referenced in NASA contract and grant instruments. (To facilitate referencing, serial numbering of paragraphs is used.)

THE NASA SCIENTIFIC AND TECHNICAL PUBLICATION PROGRAM

Scope

2. The NASA scientific and technical publication program is concerned with disseminating scientific and technical information derived from the agency's research, development, testing, technical evaluation, and operations to NASA scientists and engineers and to the scientific and technical community.

Internal Scope: Relation to Other NASA Publication Programs

3. The program encompasses scientific and technical information prepared primarily for scientists and technical personnel. Material containing scientific and technical information but directed primarily at educational and lay readership is covered by NASA Management Issuance NMI 1392.2. Material containing scientific and technical information prepared for commercial and industrial use is covered by NMIs

1129.1 and 1130.3-8. Material containing scientific and technical information, directed at NASA management, the primary purpose of which is to report plans, program/project status, fiscal, and other administrative matters, is not covered by the program; NASA-developed scientific and technical information contained in such items may be included in a suitable scientific and technical publication if appropriate.

External Scope: Relation to Outside Publication Programs

4. NASA's scientific and technical publication program works in concert with similar programs conducted by professional societies, commercial publishers, other government agencies, and related organizations. An example of such cooperation is the arrangement for the publication of proceedings arising from conferences jointly sponsored by NASA and other recognized organizations (see paragraphs 10 and 33).

NASA FORMAL PUBLICATIONS SERIES

NASA Special Publications

5. NASA Special Publications record scientific and technical information from NASA programs, projects, and missions for presentation to readers of diverse technical backgrounds. NASA Special Publications often are concerned with subjects of substantial potential public interest. This series includes, but is not necessarily limited to,

- (a) scientific summaries of mission results,
- (b) scientific photo atlases,
- (c) histories and chronologies,
- (d) selected outlook studies,

(e) comprehensive program descriptions and retrospective assessments,

(f) selected publications of the NASA Technology Utilization Program, and

(g) selected publications of the NASA Scientific and Technical Information Program, e.g., continuing bibliographies, the NASA Thesaurus.

NASA Reference Publications

6. NASA Reference Publications are compilations of scientific and technical data and information deemed to be of continuing reference value in particular subject areas or disciplines (e.g., thermodynamics). This series includes, but is not necessarily limited to,

(a) technical handbooks and manuals, critical tables;

(b) monographs, including those for design criteria;

(c) scientific and technical textbooks;

(d) state-of-the-art summaries, including critical reviews of a body of scientific or technical literature; and

(e) technical reports that provide complete and comprehensive treatment of significant contributions to scientific and technical knowledge.

NASA Technical Papers

7. NASA Technical Papers record the findings of significant work conducted by NASA scientific and technical personnel. Technical Papers are the agency's counterpart to peer-reviewed journal articles and are subject to professional review controlled by the originating Headquarters or installation office. For documentation purposes, Technical Papers are preferred to professional journal articles because Technical Papers have less stringent limitations on manuscript length and extent of graphic presentation.

NASA Technical Memorandums

8. NASA Technical Memorandums record scientific and technical findings that do not warrant or cannot be given broad dissemination because of security or restricted-readership considerations. This series includes, but is not necessarily limited to,

(a) Quick-release reports—reports typically containing preliminary data.

(b) Working papers—papers prepared for the information of peers beyond the basic work group.

(c) Presentations—preprints of material prepared for formal presentation at professional meetings, symposia, etc. (which may or may not be published subsequently in proceedings or journals).

(d) Theses/Dissertations—treatises produced by agency employees that relate to agency work and that the agency elects to publish.

(e) Bibliographies—listings of scientific or technical literature, with or without evaluation, generally in defined subject areas.

(f) Sponsored reports—reports by NASA authors of work sponsored by other agencies.

(g) Security-classified reports—scientific or technical reports or papers containing classified information.

(h) Translations—English-language translations of foreign-language scientific and technical material pertinent to agency work.

NASA Contractor Reports

9. NASA Contractor Reports record scientific and technical findings generated by NASA-sponsored research and development and related efforts that are considered desirable for release by NASA.

(a) Low-numbered subseries NASA Contractor Reports are those reporting the findings of significant work conducted by NASA contractor scientific and technical personnel. These may be regarded as analogs to NASA Technical Papers. Accordingly, they are produced and disseminated in the manner of NASA Technical Papers.

(b) High-numbered subseries NASA Contractor Reports are those reporting findings that, although reflecting new technical information, do not warrant broad dissemination. These may be regarded as analogs to NASA Technical Memorandums. Accordingly, they are produced and disseminated in the manner of NASA Technical Memorandums.

NASA Conference Publications

10. NASA Conference Publications contain compilations of scientific and technical papers, abstracts, or transcripts arising from conferences, symposia, special lecture series and seminars, and other professional meetings that NASA elects to publish.

Publication Numbering

11. Numbers for NASA publications defined in paragraphs 5–10 are assigned by the Scientific and Technical Information Branch. The numbers for each series are prefixed by a two-letter abbreviation for the series. These abbreviations are:

| | |
|-------------------------|----|
| Special Publications | SP |
| Reference Publications | RP |
| Technical Papers | TP |
| Technical Memorandums | TM |
| Contractor Reports | CR |
| Conference Publications | CP |

USE OF NON-NASA PUBLICATION MEDIA

12. All significant scientific and technical findings derived from NASA activities, including those generated by NASA-sponsored research and development and related efforts, should be disseminated either in the appropriate NASA publication defined in paragraphs 5-10 or in suitable non-NASA scientific and technical media (e.g., professional society journals, transactions, and similar periodicals, or the proceedings of conferences, symposia, and workshops). Manuscript submission by an author, without NASA review, to a journal for publication is discouraged. Regardless of the medium chosen, NASA personnel, contractors, or grantees should ensure that copies are provided to the NASA Scientific and Technical Information Facility (STIF) for inclusion in the agency's scientific and technical information system. The address and telephone number are:

NASA Scientific and
Technical Information Facility
P.O. Box 8757
Baltimore/Washington International Airport
Maryland 21240
(301) 796-5300

Duplicate Coverage

13. The release of scientific and technical information through non-NASA media does not preclude the publication of equivalent information by NASA. For example, significant findings could be reported initially in a prominent journal (whose space limitations might constrain complete presentation of text and figures); more detailed documentation of these findings could then be made in an appropriate NASA technical publication. Although authors are encouraged to publish in journals and to make oral presentations to professional societies, the emphasis remains on the use of NASA reports whenever possible. To avoid duplication, NASA material should not be published verbatim in different media, with the following possible exceptions:

(a) Preprints of presentations made at professional and technical meetings, seminars, etc., which may or may not appear in subsequently published proceedings.

(b) Preprints of journal articles.

PUBLICATIONS PRODUCTION

14. To support its publishing program, NASA maintains a centralized printing operation at Langley Research Center. In addition, the agency uses the services of the Government Printing Office and its regional units. The duplication or reproduction of

certain technical publications may be performed at Centers, depending on the distribution required. Categories that may be produced at field Centers are Technical Memorandums, Contractor Reports (high-number subseries), and Conference Publications. Copies of titles so produced should be provided to STIF (see paragraph 12). In addition, copies of all Conference Publications should be sent to Center libraries.

Distribution

15. NASA uses several channels to distribute its formal series publications to the scientific and technical community. The main channel involves automatic mailings to organizations that have preregistered their needs under eleven broad subject categories with STIF. (See Appendix A for category descriptions.) Hardcopy distribution is made automatically by the NASA Langley Research Center. Microfiche copy distribution by subject category is made automatically by STIF to organizations similarly preregistered after published documents are accessioned into the NASA scientific and technical information system. In addition to furnishing copies to those organizations on automatic category distribution, STIF will also furnish appropriate copies on demand to registered requestors. The availability of unclassified, unlimited publications to the general public is made through the National Technical Information Service (NTIS) of the Department of Commerce and through the Superintendent of Documents at the U.S. Government Printing Office.

Supplemental Distribution

16. Supplemental distribution may be given to NASA series publications to extend readership achieved by the subject category system. Lists for such supplemental distribution can be developed from requests for prior papers, known authors in the field, conference registration lists, and members of organizations or groups known to have an interest in the field, as well as from lists obtained from contractors and other agencies. Each Center should maintain such lists for the disciplines and specialties under cognizance and, when appropriate, supply supplemental lists to the Technical Publications Section with the request for a print order.

Distribution Levels

17. Distribution levels for each NASA publication series are shown in the table below. Note that documents printed at NASA Centers, typically prepared for limited readership, usually receive no category distribution. However, they may receive

subject category distribution and/or supplemental distribution, provided the originating Center furnishes Langley with the number of copies necessary to carry out such distribution.

| Series | Is category distribution given? |
|------------------------------------|---|
| SP—Langley-printed | Yes |
| SP—GPO-printed | Yes |
| RP—Langley-printed | Yes |
| RP—GPO-printed | Yes |
| TP—Langley-printed | Yes |
| TM—Langley-printed (blue cover) | Yes |
| TM—Center-printed (white cover) | Optional: Center desiring category distribution must provide Langley with sufficient quantity. |
| CR—Langley-printed (low number) | Yes |
| CR—Center-printed (high number) | Optional: Center to provide quantity. |
| CP—Langley-printed | Yes |
| CP—Center-printed | Optional: Center to provide quantity. |
| CP—GPO-printed | Yes |

NASA Authors' Choice of Medium

18. The choice of a publication medium by NASA authors should involve the use of the guidelines given in paragraph 20 and any other guidelines provided by the technical publications unit of their Center. An author's choice is subject to review as part of the center review process that applies to that medium. Headquarters Scientific and Technical Information Branch has final approval for reports selected for the Special Publications series.

Non-NASA Authors' Choice of Medium

19. The choice of a publication medium by non-NASA authors (under NASA grant or contract) is subject to contractual limitations, if any, necessitated by security, statutory, or other considerations. NASA contractors and grantees may utilize the media of their choice, including portions of the NASA formal series, for publishing scientific and technical information generated under NASA contracts and grants. NASA must be furnished an advance copy, and the material must contain appropriate acknowledgment of NASA support and identification of the contract or grant involved. NASA will require prior approval of a publication submitted to external media only when the publication results from a classified contract or grant, or when classified materiel has been provided, or when classified results are anticipated.

GENERAL PUBLICATION POLICIES AND PROCEDURES

Selecting the Proper Publication Medium

20. The division of NASA formal publications into several series reflects accepted practice in the scientific and technical community. The table on the following page will facilitate the proper choice of NASA series.

Foreign Publication Media

21. The use of a foreign publication medium is subject to restrictions in addition to those applied to other publication media. Some of these restrictions are given explicitly in NMI 2210.1 and implicitly in paragraph 7(l) of NPD 2220.5, which states "... Release of scientific and technical information will be made in conformance with NMI 1382.2."

22. To ensure that material may be submitted for publication in foreign-based media, authors shall submit an advance copy of their proposed document to the individual at their Center who has been designated by the Center director to coordinate review and release of publications in foreign media.

23. Technical data and information developed within NASA or under NASA sponsorship that is pre-identified as having significant early commercial potential may be released in the publications defined in paragraphs 5-10, provided that their initial distribution is limited and that the covers of such publications bear the legend FOR EARLY DOMESTIC DISSEMINATION, as required by NMI 2210.1.

Oral Presentation

24. The oral presentation of scientific and technical findings is one way to ensure the timely distribution of information to an appropriate audience, such as at society meetings and other professional gatherings. NASA authors who choose such an approach should consider utilizing the Technical Memorandum as a way of distributing copies of the presentation to attendees.

Recognizing Authors, Contributors, Sources, Sponsors, and Monitors

Authorship

25. The authorship of NASA publications is "reserved to persons who participate in the performance of the work from which the scientific and technical information results" (NPD 2220.5) and who can effectively defend the main technical content of the publication to a peer group. Because of

| If manuscript is of this nature . . . | then use this NASA series. |
|--|---|
| Abstracts of conference papers | CP |
| Article for a technical magazine | none required; consider TP for expanded treatment |
| Article for a professional journal | |
| Atlas of scientific imagery | TM for preprint |
| Bibliography, with minimal annotation | SP |
| Bibliography, with extensive annotation | TM |
| Bibliography, continuing | RP |
| Chronology of major project/program/mission | SP |
| Computer program application | SP |
| Conference proceedings | TM |
| Contractor results and findings report | CP |
| Critical review of the literature | CR |
| Critical tables | TP or RP |
| Data compilation, limited use | RP |
| Data compilation, extensive use | TM |
| Design standards/environment | RP |
| Dissertation by employees, relating to work | RP |
| Engineering report | TM |
| Handbook | TP |
| History | RP |
| Letter (to "Letters" journal) | SP |
| Literature survey, review | none required |
| Manual | TP or RP |
| Monograph | RP |
| Paper for meeting presentation | RP |
| Preprint of paper for a professional meeting | TM |
| Proceedings of a workshop, conference, seminar, etc. | TM |
| Program description or summary | CP |
| Preliminary results report | SP |
| Quick-release report | TM |
| Report to another agency | TM |
| Reprint (of journal article) | TM |
| Research report | none required |
| Review paper | TP |
| Security-classified report | TP |
| Sponsored research report (NASA is sponsor) | TM |
| Sponsored research report (external sponsor) | CR |
| Standards for design | TM |
| State-of-the-art review summary | RP |
| Summary of mission results—scientific | TP or RP |
| Tables of critical values | SP |
| Technical report—complete, comprehensive | RP |
| Textbook, scientific or technical | RP |
| Thesis by employee, relating to work | TM |
| Translation | TM |
| Working paper (external circulation) | TM |

the complexity of scientific and technical work, many publications in the field have co-authors. The authors' names should appear in a sequence that indicates the amount of responsibility assumed for the

effort; that is, the first author is the chief contributor and writer, and other authors follow in the order of the importance of their respective contributions in the performance of the work. However, NASA employees may not be listed as co-authors of Contractor Reports. In cases in which NASA employees are contributors (as opposed to contract monitors) to contract or grant work, such work should be documented in a different series.

Source Credit

26. Source credit for material from non-NASA publications appearing in a NASA report should be given. In addition, in the case of copyrighted source material, authors are responsible for securing permission to reprint from the copyright holder.

Sponsorship

27. When NASA undertakes work for another agency, the NASA authors should report the scientific and technical findings in the TM series. Appropriate indication of sponsorship should be given on the title page and the standard report information page. Such a publication will not, of course, preclude the sponsoring agency from publishing the work in its own series.

28. When NASA is the sponsoring agency, contractor and grantee authors should ensure that all publications deriving from NASA-sponsored research and development and related efforts have an indication of such support clearly displayed. In the case of journal articles, the preferred indication is a first-page footnote acknowledging NASA support and providing the contract or grant number under which the work was performed.

References

29. Reference list preparation should encompass all references cited in the body of the NASA report, with the consolidated result placed at the end of the report. The format for such a listing, in general, should follow the accepted practices of the discipline pertaining to the work. A preferred practice for NASA publications is to list works alphabetically by author and chronologically within same-author entries. This permits the in-text citation to be of the form "(Jones, 1975)."

Editorship

30. Editorship recognition for certain publication forms, such as Conference Proceedings, is justified only in those cases in which the editor (or editors) has applied scientific and technical expertise and judgment in compiling and coordinating the

materials. Merely shepherding a collection of papers through the production and printing process and performing associated administrative tasks does not warrant recognition on the title page.

Other Contributions

31. Other contributions by individuals to the substantive scientific and technical content of a report in a nonauthor or noneditor way may deserve to be acknowledged. Normal assistance furnished by Center personnel, including professional consultation or help from groups or individuals not directly related to the work, is usually excluded from acknowledgment. Also excluded are acknowledgments made to supervisors or technical committees whose comments and advice result from regular work assignments. However, voluntary assistance received from outside the center should be acknowledged. When an acknowledgment is warranted, it is included in the last paragraph of the introduction, not in a separate acknowledgment section. Acknowledgments should be factual, not flowery.

Contract/Grant Monitors

32. Contract/grant monitors should not be listed as co-authors of NASA Contractor Reports. Contractor/grantee-authored NASA publications should, of course, include the name of the NASA monitor or project manager and his/her organizational affiliation on the Standard Report Information Form in the "supplementary notes" section. Although this is stated principally to provide an interested reader who desires further information with a NASA contract, it also credits the project manager/monitor for his/her role in publishing the report. In a contractor-originated SP, the name of the NASA project manager, division, and the contract number is given in a preface to the report.

Conference Sponsorship

33. Conference sponsorship should be indicated on the title page of any proceedings published by NASA. When NASA shares sponsorship with other organizations, NASA's name shall appear in the list of sponsors. The editors of the proceedings and their organization affiliations may appear on the title page. Such a listing of editors is appropriate only when the editors have exercised their scientific and technical expertise in the editorial process (see paragraph 30).

Copyright Transfers

34. Copyright transfers submitted by NASA authors for journal publication concerning materials

that derive from the author's official duties as a U.S. Government employee cannot be made; no U.S. copyright protection exists under these conditions. When submitting material for external publication, NASA authors should consult Agency counsel concerning any agreements publishers may wish them to sign.

SELECTED PUBLISHING DETAILS

Standards

35. Format and style standards for NASA scientific and technical publications are established by the following sources. If conflicting guidance is encountered, the sequence of the list shall govern.

(a) Instructions established by the Scientific and Technical Information Branch.

(b) Instructions implementing STIB requirements issued by field installations.

(c) *NASA Publications Manual*, NASA SP-7013.

(d) *GPO Style Manual*.

(e) *NASA Graphics Standards Manual*, NHB 1430.2.

Covers for NASA Publications Series

36. Except for the NASA Special Publication series, the cover formats of NASA formal series publications defined in paragraphs 5-10 are standardized. Cover format standards are established by the Scientific and Technical Information Branch.

Cover Stock

37. The principal criterion for selecting a cover stock is durability. Selected publications in the CP, RP, and SP series may receive hard cover treatment (casebound), as determined by STIB. Casebinding for prestige alone is undesirable.

Disclaimers

38. The use of disclaimers and similar notices is discouraged. However, a notice may be employed to alert the reader that a particular publication is

(a) A presentation of preliminary findings, subject to revision as analysis proceeds.

(b) A formal draft or working paper, intended to solicit comments and ideas from a technical peer group.

(c) A preprint of a paper to be presented at a professional meeting.

(d) A preprint of an article to appear in a professional journal or technical magazine.

The following is an example of a statement that may appear on the title page:

This is a preprint of a paper intended for publication in a journal or proceedings. Since changes may be made before publication, this preprint is made available with the understanding that it will not be cited or reproduced without the permission of the author.

Disclaimers calling attention to nonedited quick releases or nonresponsibility of issuing agency may not be used.

Color

39. The use of color increases publishing costs and should be used only when it is necessary to convey the scientific and technical material in a clear and unambiguous fashion.

Placement of Figures and Illustrations

40. Figures and illustrations should appear as close to their initial reference in the text as is practicable, given size and layout considerations. Grouping figures and illustrations serially at the end of a report is appropriate only when such placement facilitates necessary expeditious release or large groups of illustrations create text/layout problems.

Use of SI Units

41. The use of the International System of Units is required by NPD 2220.4 in material reported in NASA scientific and technical publications. When a discipline uses non-SI units, these may be employed in addition to the SI units and presented in parentheses following the SI-measured quantities. Reports containing such mixed-unit measures may contain appropriate conversion tables in an appendix.

Symbols

42. The use of symbols in NASA scientific and technical publications should follow standards for the designations of letter and mathematical symbols used by the various disciplines. NASA scientific and technical publications must include provisions for the definition of any letter or mathematical symbols employed.

Microphotography

43. All documents entering the NASA Scientific and Technical Information System are subject to microphotography. To ensure the legibility of end products of the microphotographic process, preparers of reports should observe the guidelines for copy preparation formulated by the Scientific and Technical Information Branch. These guidelines are presented in Appendix B.

Documentation for Retrieval and Distribution

44. For those NASA publications in categories requiring incorporation of the Standard Report Information Form, authors should coordinate with Center technical publications specialists to ensure completion of all entries. In particular, care should be taken in specifying the subject category and key words, because these determine how the report will be entered into the NASA Scientific and Technical Information System, subsequently announced and cross-referenced, and distributed to registered organizations. The subject categories are those used in the abstract journal *STAR* (Scientific and Technical Aerospace Reports) and its companion journal *IAA* (International Aerospace Abstracts); see Appendix A.

TABLE A-1
DISTRIBUTION DIVISIONS

A. AERONAUTICS

Includes aeronautics (general); aerodynamics; air transportation and safety; aircraft communications and navigation; aircraft design, testing and performance; aircraft instrumentation; aircraft propulsion and power; aircraft stability and control; and research and support facilities (air).

For related information see also *Astronautics*.

B. ASTRONAUTICS

Includes astronautics (general); astrodynamics; ground support systems and facilities (space); launch vehicles and space vehicles; space transportation; spacecraft communications, command and tracking; spacecraft design, testing and performance; spacecraft instrumentation; and spacecraft propulsion and power.

For related information see also *Aeronautics*.

C. CHEMISTRY AND MATERIALS

Includes chemistry and materials (general); composite materials; inorganic and physical chemistry; metallic materials; nonmetallic materials; and propellants and fuels.

D. ENGINEERING

Includes engineering (general); communications; electronics and electrical engineering; fluid mechanics and heat transfer; instrumentation and photography; lasers and masers; mechanical engineering; quality assurance and reliability; and structural mechanics.

For related information see also *Physics*.

E. GEOSCIENCES

Includes geosciences (general); earth resources; energy production and conversion; environment pollution; geophysics; meteorology and climatology; and oceanography.

For related information see also *Space Sciences*.

F. LIFE SCIENCES

Includes life sciences (general); aerospace medicine; behavioral sciences; man/system technology and life support; and planetary biology.

G. MATHEMATICAL AND COMPUTER SCIENCES

Includes mathematical and computer sciences (general); computer operations and hardware; computer programming and software; computer systems; cybernetics; numerical analysis; statistics and probability; systems analysis; and theoretical mathematics.

H. PHYSICS

Includes physics (general); acoustics; atomic and molecular physics; nuclear and high-energy physics; optics; plasma physics; solid-state physics; thermodynamics and statistical physics.

For related information see also *Engineering*.

I. SOCIAL SCIENCES

Includes social sciences (general); administration and management; documentation and information science; economics and cost analysis; law and political science; and urban technology and transportation.

J. SPACE SCIENCES

Includes space sciences (general); astronomy; astrophysics; lunar and planetary exploration; solar physics; and space radiation.

For related information see also *Geosciences*.

K. GENERAL

TABLE A-2

STAR Subject Categories

AERONAUTICS

Includes aeronautics (general); aerodynamics; air transportation and safety; aircraft communications and navigation; aircraft design, testing and performance; aircraft instrumentation; aircraft propulsion and power; aircraft stability and control; and research and support facilities (air).

For related information see also *Astronautics*.

01 AERONAUTICS (GENERAL)

02 AERODYNAMICS

Includes aerodynamics of bodies, combinations, wings, rotors, and control surfaces; and internal flow in ducts and turbomachinery.

For related information see also *34 Fluid Mechanics and Heat Transfer*.

03 AIR TRANSPORTATION AND SAFETY

Includes passenger and cargo air transport operations; and aircraft accidents.

For related information see also *16 Space Transportation* and *85 Urban Technology and Transportation*.

04 AIRCRAFT COMMUNICATIONS AND NAVIGATION

Includes digital and voice communication with aircraft; air navigation systems (satellite and ground based); and air traffic control.

For related information see also *17 Spacecraft Communications, Command and Tracking* and *32 Communications*.

05 AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Includes aircraft simulation technology.

For related information see also *18 Spacecraft Design, Testing and Performance* and *39 Structural Mechanics*.

06 AIRCRAFT INSTRUMENTATION

Includes cockpit and cabin display devices; and flight instruments.

For related information see also *19 Spacecraft Instrumentation* and *35 Instrumentation and Photography*.

07 AIRCRAFT PROPULSION AND POWER

Includes prime propulsion systems and systems components, e.g., gas turbine engines and compressors; and on-board auxiliary power plants for aircraft.

For related information see also *20 Spacecraft Propulsion and Power*, *28 Propellants and Fuels*, and *44 Energy Production and Conversion*.

08 AIRCRAFT STABILITY AND CONTROL

Includes aircraft handling qualities; piloting; flight controls; and autopilots.

09 RESEARCH AND SUPPORT FACILITIES (AIR)

Includes airports, hangars and runways; aircraft repair and overhaul facilities; wind tunnels; shock tube facilities; and engine test blocks.

For related information see also *14 Ground Support Systems and Facilities (Space)*.

ASTRONAUTICS

Includes astronautics (general); astrodynamics; ground support systems and facilities (space); launch vehicles and space vehicles; space transportation; spacecraft communications, command and tracking; spacecraft design, testing and performance; spacecraft instrumentation; and spacecraft propulsion and power.

For related information see also *Aeronautics*.

12 ASTRONAUTICS (GENERAL)

For extraterrestrial exploration see *91 Lunar and Planetary Exploration*.

13 ASTRODYNAMICS

Includes powered and free-flight trajectories; and orbit and launching dynamics.

14 GROUND SUPPORT SYSTEMS AND FACILITIES (SPACE)

Includes launch complexes, research and production facilities; ground support equipment, e.g., mobile transporters; and simulators.

For related information see also *09 Research and Support Facilities (Air)*.

15 LAUNCH VEHICLES AND SPACE VEHICLES

Includes boosters; manned orbital laboratories; reusable vehicles; and space stations.

16 SPACE TRANSPORTATION

Includes passenger and cargo space transportation, e.g., shuttle operations; and rescue techniques.

For related information see also *03 Air Transportation and Safety* and *85 Urban Technology and Transportation*.

17 SPACECRAFT COMMUNICATIONS, COMMAND AND TRACKING

Includes telemetry; space communications networks; astronavigation; and radio blackout.

For related information see also *04 Aircraft Communications and Navigation* and *32 Communications*.

18 SPACECRAFT DESIGN, TESTING AND PERFORMANCE

Includes spacecraft thermal and environmental control; and attitude control.

For life support systems see *54 Man/System Technology and Life Support*. For related information see also *05 Aircraft Design, Testing and Performance* and *39 Structural Mechanics*.

19 SPACECRAFT INSTRUMENTATION

For related information see also *06 Aircraft Instrumentation* and *35 Instrumentation and Photography*.

20 SPACECRAFT PROPULSION AND POWER

Includes main propulsion systems and components, e.g., rocket engines; and spacecraft auxiliary power sources.

For related information see also *07 Aircraft Propulsion and Power*, *28 Propellants and Fuels*, and *44 Energy Production and Conversion*.

CHEMISTRY AND MATERIALS

Includes chemistry and materials (general); composite materials; inorganic and physical chemistry; metallic materials; nonmetallic materials; and propellants and fuels.

23 CHEMISTRY AND MATERIALS (GENERAL)

Includes biochemistry and organic chemistry.

24 COMPOSITE MATERIALS

Includes laminates.

25 INORGANIC AND PHYSICAL CHEMISTRY

Includes chemical analysis, e.g., chromatography; combustion theory; electrochemistry; and photochemistry.

For related information see also *77 Thermodynamics and Statistical Physics*.

26 METALLIC MATERIALS

Includes physical, chemical, and mechanical properties of metals, e.g., corrosion; and metallurgy.

27 NONMETALLIC MATERIALS

Includes physical, chemical, and mechanical properties of plastics, elastomers, lubricants, polymers, textiles, adhesives, and ceramic materials.

28 PROPELLANTS AND FUELS

Includes rocket propellants, igniters, and oxidizers; storage and handling; and aircraft fuels.

For related information see also *07 Aircraft Propulsion and Power*, *20 Spacecraft Propulsion and Power*, and *44 Energy Production and Conversion*.

ENGINEERING

Includes engineering (general); communications; electronics and electrical engineering; fluid mechanics and heat transfer; instrumentation and photography; lasers and masers; mechanical engineering; quality assurance and reliability; and structural mechanics.

For related information see also *Physics*.

31 ENGINEERING (GENERAL)

Includes vacuum technology; control engineering; display engineering; and cryogenics.

32 COMMUNICATIONS

Includes land and global communications; communications theory; and optical communications.

For related information see also *04 Aircraft Communications and Navigation* and *17 Spacecraft Communications, Command and Tracking*.

33 ELECTRONICS AND ELECTRICAL ENGINEERING

Includes test equipment and maintainability; components, e.g., tunnel diodes and transistors; microminiaturization; and integrated circuitry.

For related information see also *60 Computer Operations and Hardware* and *76 Solid-State Physics*.

34 FLUID MECHANICS AND HEAT TRANSFER

Includes boundary layers; hydrodynamics; fluidics; mass transfer; and ablation cooling.

For related information see also *02 Aerodynamics* and *77 Thermodynamics and Statistical Physics*.

35 INSTRUMENTATION AND PHOTOGRAPHY

Includes remote sensors; measuring instruments and gages; detectors; cameras and photographic supplies; and holography.

For aerial photography see *43 Earth Resources*. For related information see also *06 Aircraft Instrumentation* and *19 Spacecraft Instrumentation*.

36 LASERS AND MASERS

Includes parametric amplifiers.

37 MECHANICAL ENGINEERING

Includes auxiliary systems (non-power); machine elements and processes; and mechanical equipment.

38 QUALITY ASSURANCE AND RELIABILITY

Includes product sampling procedures and techniques; and quality control.

39 STRUCTURAL MECHANICS

Includes structural element design and weight analysis; fatigue; and thermal stress.

For applications see *05 Aircraft Design, Testing and Performance* and *18 Spacecraft Design, Testing and Performance*.

GEOSCIENCES

Includes geosciences (general); earth resources; energy production and conversion; environment pollution; geophysics; meteorology and climatology; and oceanography.

For related information see also *Space Sciences*.

42 GEOSCIENCES (GENERAL)

43 EARTH RESOURCES

Includes remote sensing of earth resources by aircraft and spacecraft photogrammetry; and aerial photography.

For instrumentation see *35 Instrumentation and Photography*.

44 ENERGY PRODUCTION AND CONVERSION

Includes specific energy conversion systems, e.g., fuel cells and batteries; global sources of energy; fossil fuels; geophysical conversion; hydroelectric power; and wind power.

For related information see also *07 Aircraft Propulsion and Power*, *20 Spacecraft Propulsion and Power*, *28 Propellants and Fuels*, and *85 Urban Technology and Transportation*.

45 ENVIRONMENT POLLUTION

Includes air, noise, thermal and water pollution; environment monitoring; and contamination control.

46 GEOPHYSICS

Includes aeronomy; upper and lower atmosphere studies; ionospheric and magnetospheric physics; and geomagnetism.

For space radiation see *93 Space Radiation*.

47 METEOROLOGY AND CLIMATOLOGY

Includes weather forecasting and modification.

48 OCEANOGRAPHY

Includes biological, dynamic and physical oceanography, and marine resources.

LIFE SCIENCES

Includes life sciences (general); aerospace medicine; behavioral sciences; man/system technology and life support; and planetary biology.

51 LIFE SCIENCES (GENERAL)

Includes genetics.

52 AEROSPACE MEDICINE

Includes physiological factors; biological effects of radiation; and weightlessness.

53 BEHAVIORAL SCIENCES

Includes psychological factors; individual and group behavior; crew training and evaluation; and psychiatric research.

54 MAN/SYSTEM TECHNOLOGY AND LIFE SUPPORT

Includes human engineering; biotechnology; and space suits and protective clothing.

55 PLANETARY BIOLOGY

Includes exobiology; and extraterrestrial life.

MATHEMATICAL AND COMPUTER SCIENCES

Includes mathematical and computer sciences (general); computer operations and hardware; computer programming and software; computer systems; cybernetics; numerical analysis; statistics and probability; systems analysis; and theoretical mathematics.

59 MATHEMATICAL AND COMPUTER SCIENCES (GENERAL)

60 COMPUTER OPERATIONS AND HARDWARE

Includes computer graphics and data processing.

For components see *33 Electronics and Electrical Engineering*.

61 COMPUTER PROGRAMMING AND SOFTWARE

Includes computer programs, routines, and algorithms.

62 COMPUTER SYSTEMS

Includes computer networks.

63 CYBERNETICS

Includes feedback and control theory.

For related information see also *54 Man/System Technology and Life Support*.

64 NUMERICAL ANALYSIS

Includes iteration, difference equations, and numerical approximation.

65 STATISTICS AND PROBABILITY

Includes data sampling and smoothing; Monte Carlo method; and stochastic processes.

66 SYSTEMS ANALYSIS

Includes mathematical modeling; network analysis; and operations research.

67 THEORETICAL MATHEMATICS

Includes topology and number theory.

PHYSICS

Includes physics (general); acoustics; atomic and molecular physics; nuclear and high-energy physics; optics; plasma physics; solid-state physics; and thermodynamics and statistical physics.

For related information see also *Engineering*.

70 PHYSICS (GENERAL)

For geophysics see *46 Geophysics*. For astrophysics see *90 Astrophysics*. For solar physics see *92 Solar Physics*.

71 ACOUSTICS

Includes sound generation, transmission, and attenuation.

For noise pollution see *45 Environment Pollution*.

72 ATOMIC AND MOLECULAR PHYSICS

Includes atomic structure and molecular spectra.

73 NUCLEAR AND HIGH-ENERGY PHYSICS

Includes elementary and nuclear particles; and reactor theory.

For space radiation see *93 Space Radiation*.

74 OPTICS

Includes light phenomena.

75 PLASMA PHYSICS

Includes magnetohydrodynamics and plasma fusion.

For ionospheric plasmas see *46 Geophysics*. For space plasmas see *90 Astrophysics*.

76 SOLID-STATE PHYSICS

Includes superconductivity.

For related information see also *33 Electronics and Electrical Engineering* and *36 Lasers and Masers*.

77 THERMODYNAMICS AND STATISTICAL PHYSICS

Includes quantum mechanics; and Bose and Fermi statistics.

For related information see also *25 Inorganic and Physical Chemistry* and *34 Fluid Mechanics and Heat Transfer*.

SOCIAL SCIENCES

Includes social sciences (general); administration and management; documentation and information science; economics and cost analysis; law and political science; and urban technology and transportation.

80 SOCIAL SCIENCES (GENERAL)

Includes educational matters.

81 ADMINISTRATION AND MANAGEMENT

Includes management planning and research.

82 DOCUMENTATION AND INFORMATION SCIENCE

Includes information storage and retrieval technology; micrography; and library science.

For computer documentation see *61 Computer Programming and Software*.

83 ECONOMICS AND COST ANALYSIS

Includes cost effectiveness studies.

84 LAW AND POLITICAL SCIENCE

Includes space law, international law; international cooperation; and patent policy.

85 URBAN TECHNOLOGY AND TRANSPORTATION

Includes applications of space technology to urban problems; technology transfer; technology assessment; and surface and mass transportation.

For related information see *03 Air Transportation and Safety*, *16 Space Transportation*, and *44 Energy Production and Conversion*.

SPACE SCIENCES

Includes space sciences (general); astronomy; astrophysics; lunar and planetary exploration; solar physics; and space radiation.

For related information see also *Geosciences*.

88 SPACE SCIENCES (GENERAL)**89 ASTRONOMY**

Includes radio and gamma-ray astronomy; celestial mechanics; and astrometry.

90 ASTROPHYSICS

Includes cosmology; and interstellar and interplanetary gases and dust.

91 LUNAR AND PLANETARY EXPLORATION

Includes planetology; and manned and unmanned flights.

For spacecraft design see *18 Spacecraft Design, Testing and Performance*. For space stations see *15 Launch Vehicles and Space Vehicles*.

92 SOLAR PHYSICS

Includes solar activity, solar flares, solar radiation and sunspots.

93 SPACE RADIATION

Includes cosmic radiation; and inner and outer earth's radiation belts.

For biological effects of radiation see *52 Aerospace Medicine*. For theory see *73 Nuclear and High-Energy Physics*.

GENERAL**99 GENERAL**

APPENDIX B

GUIDELINES FOR COPY PREPARATION FOR MICROFICHE

NASA makes extensive use of microphotography as a fast, economical, and efficient way to supply information to researchers everywhere. Some 80 percent of NASA scientific and technical documents are available only on microfiche; but the usefulness of the technique, which employs a compression ratio of 24:1, is wholly dependent on the quality of the material photographed. The following methods of copy preparation can lead to high-quality microfiche:

1. Cleanly types manuscript originals;
2. Good offset or letterpress printing;
3. High-quality duplication of either of the above.

Copy-preparation characteristics that surely will create unsatisfactory microfiche include the following:

1. Broken, dirty, or uneven typing impressions;
2. Typefaces smaller than 10 points in size;
3. Paper having show-through from the reverse side;
4. Color prints or transparencies and colored graphs;
5. Duplication methods producing copies of either poor or mixed contrast, blurred images, or factitious tones (e.g., "dittos," photostats, etc.).

In general, good copy produces good microfiche. In addition, these points are worth following at all times:

- To the extent possible, figures and legends should not be rotated 90° because not all microfiche viewers permit convenient rotation.
- Do not use paper larger than 8½ by 11 inches. Leave a margin of at least 1 inch all around the image area, so that information will not be lost during machine cutting of the original prior to photography.
- If a gatefold is truly essential, it should be sectionalized for reproduction as separate 8½ by 11-inch pages that a reader can examine one at a time, from left to right.
- Screened halftone photographs seldom reproduce in the microfiche process. If quality reproduction of image detail is important, best results are attained by use of a glossy photoprint of the proper proportions.
- When photoprint fidelity is essential (e.g., for interpretation) footnote source of photo availability.
- Oversize drawings and computer printouts that have already been reduced will not reproduce satisfactorily.
- Graphs originally planned for multicolor reproduction can usually be adapted to one-color microfiche use by patterned lines (e.g., dots, dashes, etc.).
- Sequentially number all pages with arabic numbers, beginning with the title page.
- Every attempt should be made to have illustrations and tables appear on the page where first mentioned.
- Footnotes and references should appear on the pages on which they are introduced.
- All references should be separately listed at the end of the document.

The important thing to remember is that the original copy is subject to at least three generations of photographic reproduction to make the microfiche ultimately supplied to the user. Image clarity for viewing in a reader as well as making blowback copy depends largely on the thoughtfulness and tidiness with which the original copy was prepared.

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